

Anti-predator behavior

Predation vs. anti-predation

Evolutionary arm race

Anti-predation strategy:

Two categories

1. Avoiding detection by predators
2. Encountering predators

1. Avoiding detection by predators

Cryptic: (hidden through camouflaging)
blending into environment

Examples?

Examples of camouflage

Rock ptarmigan

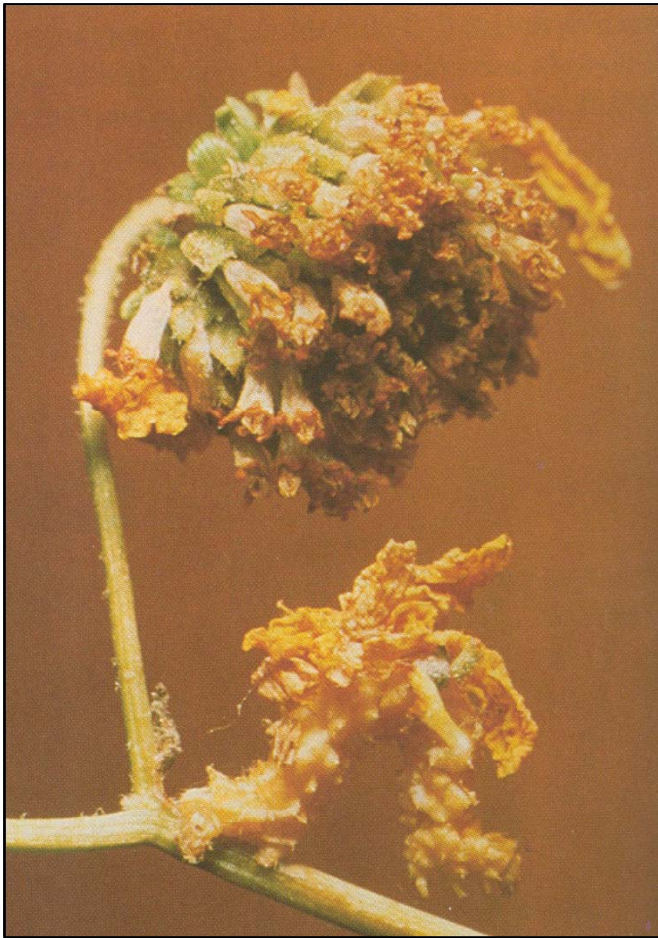


Winter plumage



Summer plumage

Examples of camouflage



Improve camouflage.....

Geometrid moth
caterpillar hooks flower
petals onto its back

Examples of camouflage



Examples of camouflage



Peppered moth:

Black form once extremely rare
Whitish form dominant
in urban regions of England

From 1850-1950:

Black form replaces whitish form

Hypothesis: industrial soot had
darken the color of forest trees
→ Bird predator eat whitish ones

Moth vs. polluted tree

Before 1800



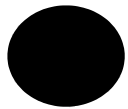
Lighter background (trees)

1850-1950

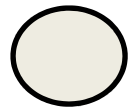


Darker background (trees)

A good example of nature selection

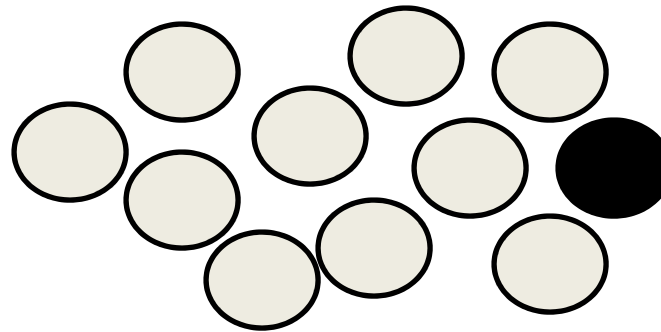


Black form
a gene is
mutated
to black

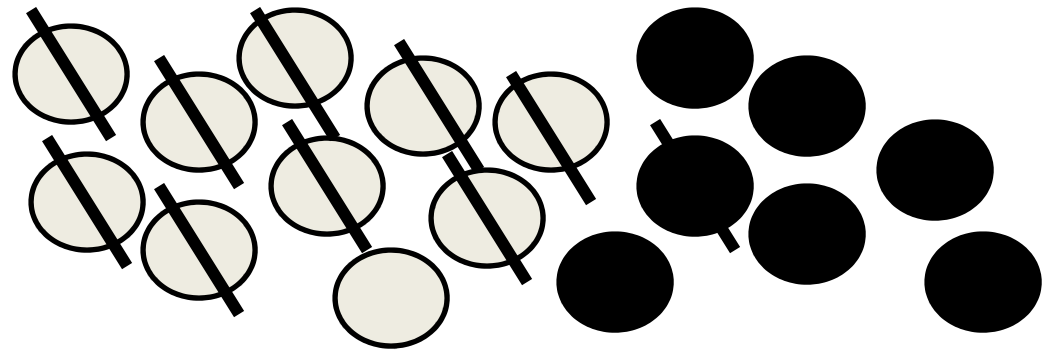


Whitish form

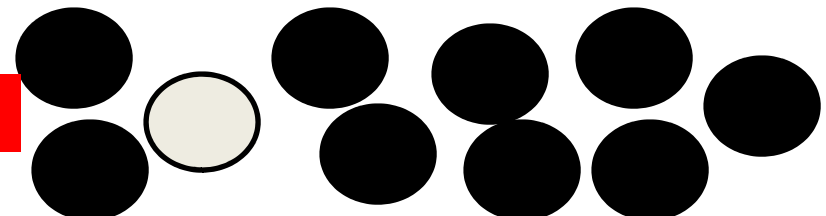
Before forest darkened



After forest darkened



After forest darkened



Mutated gene survives

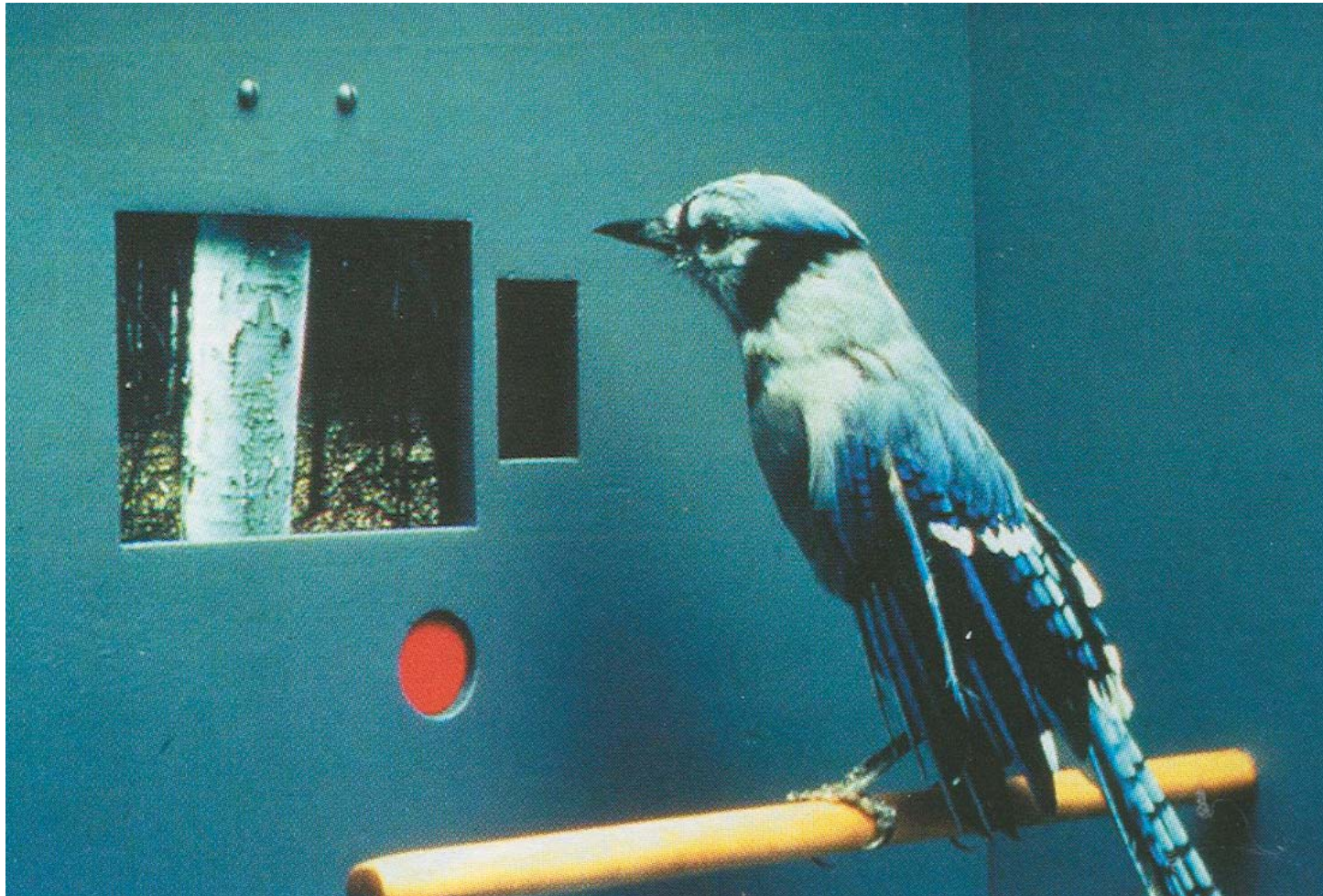


Does cryptic behavior work?



How to design an experiment
test whether bird predators
are harder to detect
cryptic prey?

Does cryptic behavior work?



What kind of learning behavior it is?

Anti-predation strategy:

Two categories

1. Avoiding detection by predators
2. Encountering predators

Anti-predation strategy:

Two categories

1. Avoiding detection by predators
 - cryptic behavior
2. Encountering predators
 - warning signals

Encounter predators:

1. Warning predators

Warning predators (don't eat me, I am poisonous)



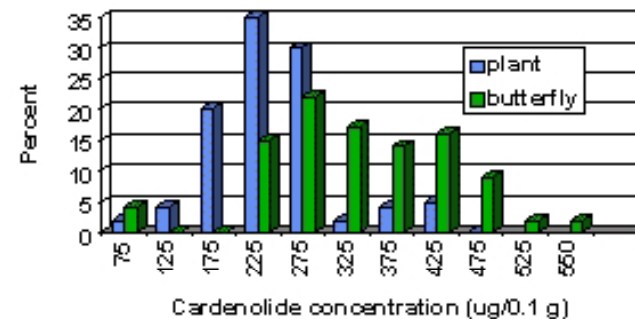
Anti-predator strategy:

Conspicuous orange and black pattern on its wings.



Milkweed and Monarch
Cardenolide Concentrations

A. viridis (data from Malcolm and Brower 1989)



Its larvae feed upon poisonous milkweeds, they save the potent plant poison in their tissues

Encounter predators:



What antipredator strategy the monarch butterfly have evolved against its predators?

Warning against predator



Blue jays eats the butterfly and survives,
but the toxic is the most unpleasant, educational experience
This jay would never eat any bug with **black-yellow** pattern.

Nauseated predators learn to avoid the color pattern of the prey that make them sick, the door for deception is opened!

Some edible, non-poisonous prey deceive educated predators into leaving them alone by looking like bad-tasting ones...

Batesian mimicry

The protective resemblance in appearance of a palatable or harmless species to an unpalatable or dangerous species that is usually avoided by predators.

Batesian mimicry





The Batesian mimicry occurs when two species live at the same area.

FIGURE 18.20. Batesian mimicry in females of the swallowtail butterfly *Papilio dardanus*. The *left* column shows three different unpalatable model species in the family Danaidae, and the *right* column shows palatable *Papilio dardanus* mimics. All three patterns are found as polymorphisms within populations of *P. dardanus*.

Batesian mimicry

(Conant 1958)



Eastern Coral Snake
(venomous)



Scarlet King Snake
(non-venomous)

Batesian mimicry

They look like..

a paper wasp a yellow-jacket a bee



But actually they are harmless flies

Batesian mimicry



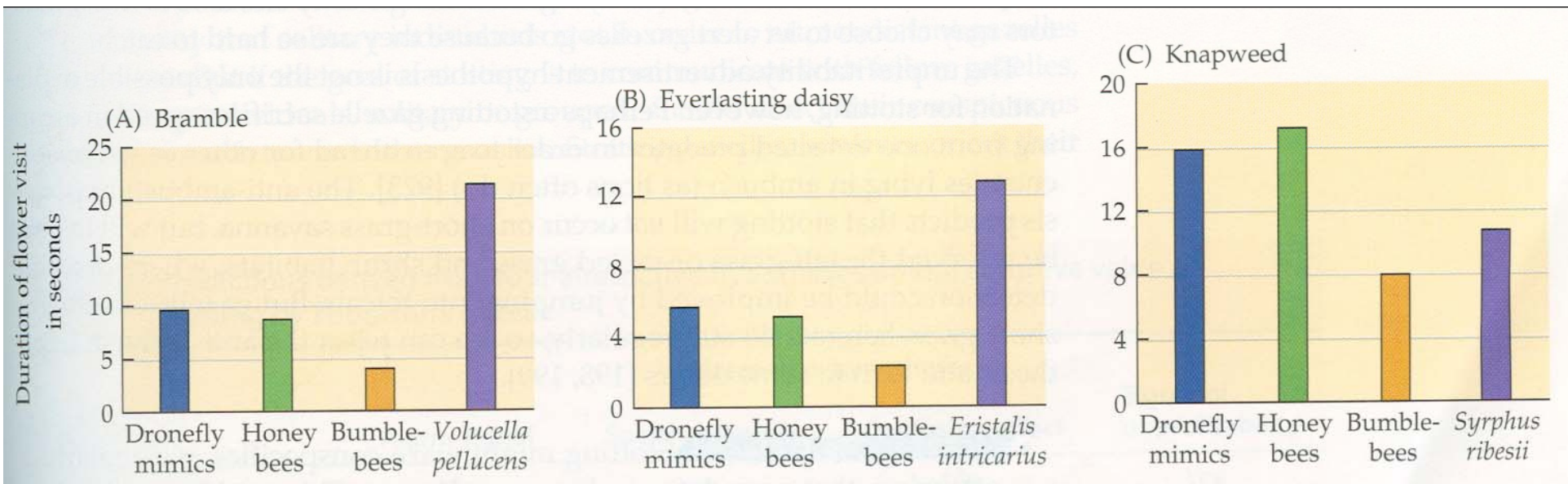
(a) Cuckoo bee



(b) Yellow jacket

Behavioral Batesian mimicry

Droneflies that mimic honey bees spend about the same amount of time as honey bees feeding on the flowers of various plants



Mullerian mimicry

Müllerian mimicry is a natural phenomenon when two or more harmful species, that may or may not be closely related and share one or more common predators, have come to mimic each other's warning signals.

Mullerian mimicry

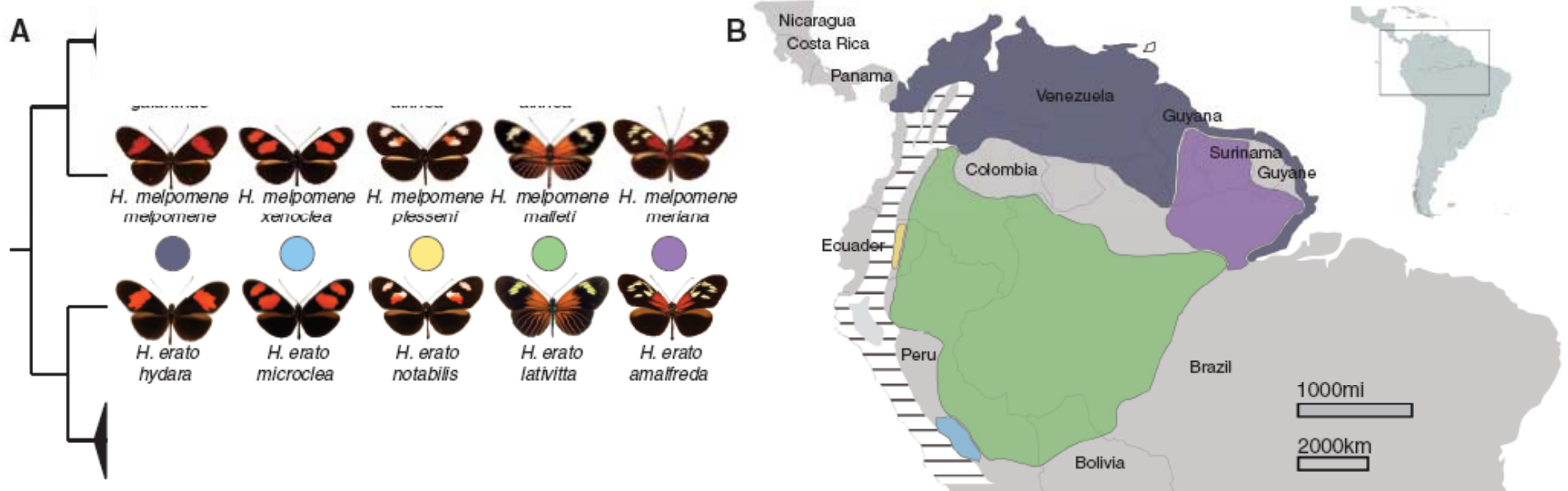


Tree frog: *D. fasiri*



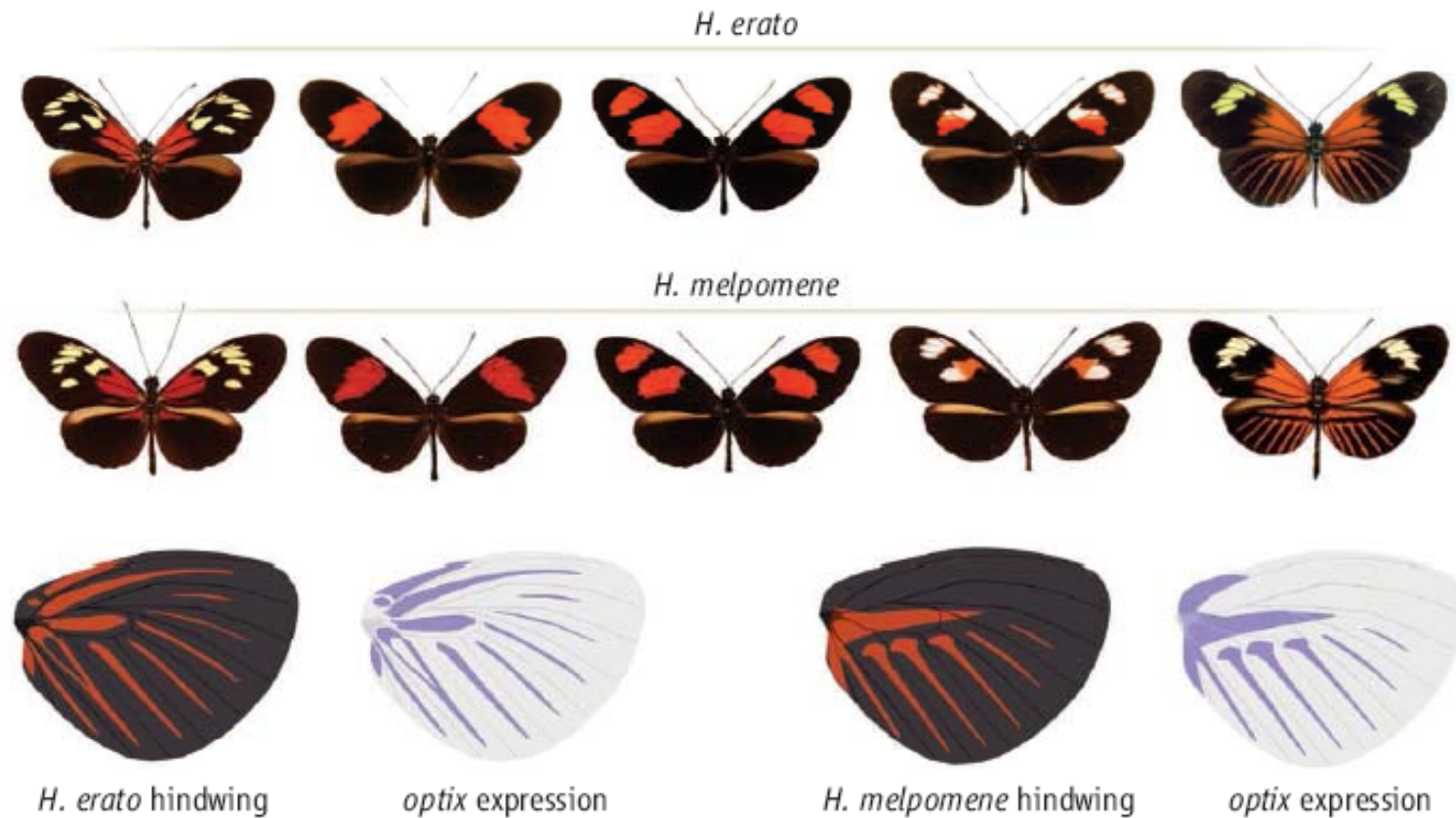
D. summari

Mullerian mimicry



Two different species at the same area evolve mimicry of color pattern

The differential expression of a single gene (*optix*) induces the color change



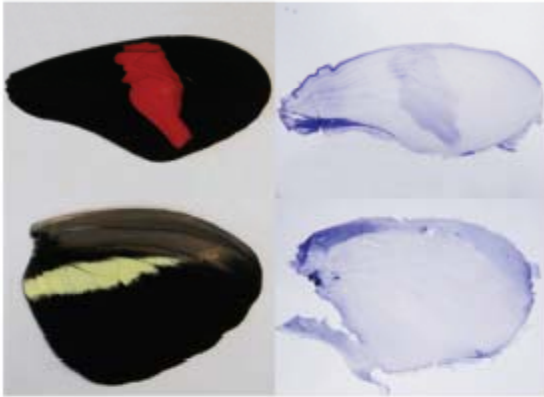
The differential expression of a single gene (*optix*) induces the color change:

These two species have the exact same *optix* gene – same coding sequence (same amino acid sequence)

The only difference is the non-coding region: induce gene expresses in some tissues but not others.

The only difference is the non-coding region: induce gene expresses in some tissues but not others.

H. erato petiverana



H. erato erato



H. cydno galanthus



H. melpomene rosina



H. melpomene malleti



H. melpomene plesseni



Encounter predators:

1. Warning behavior
2. Stay vigilant to flee

Stay vigilant to flee

A sleeping duck is
only half asleep



One of the hemispheres of these ducks was functioning at 100% capacity while the other hemisphere was in a sleep mode. Apparently the duck has the capacity to sleep with half the brain at a time doing the sleeping and the other half being fully responsive to the environment around them.

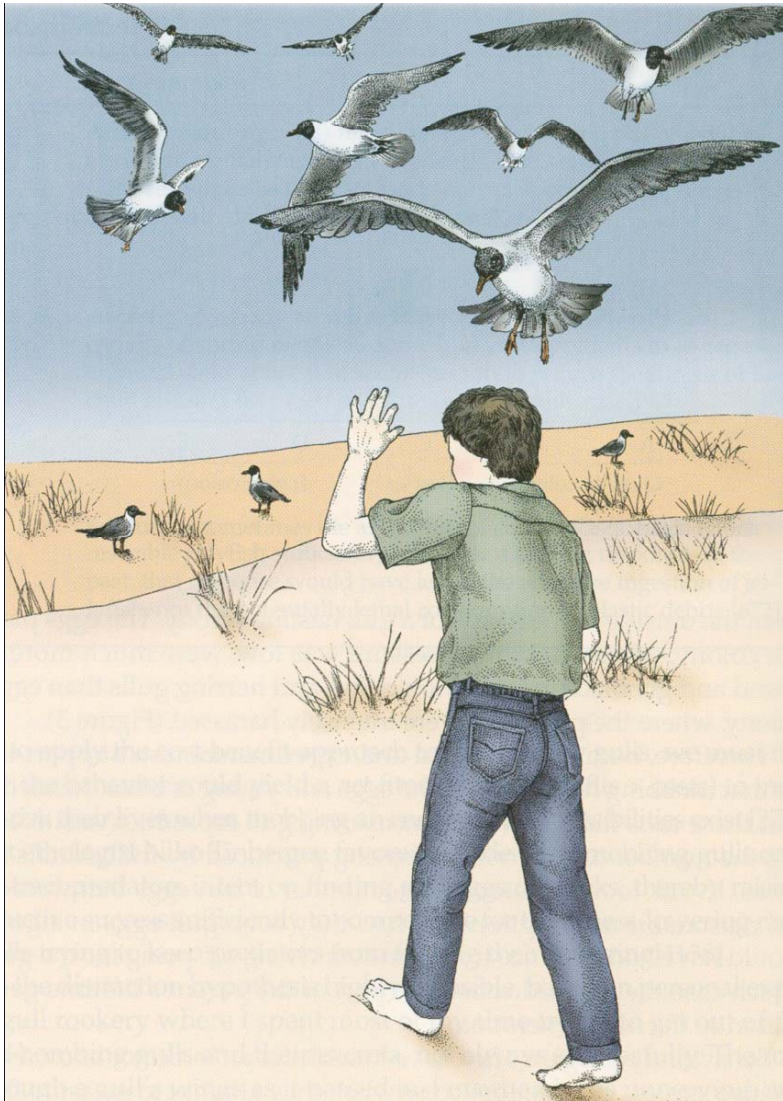
Stay vigilant to flee
ducks sleep in a group



Encounter predators:

1. Warning behavior
2. Stay vigilant to flee
3. Attacking predator

Mobbing behavior

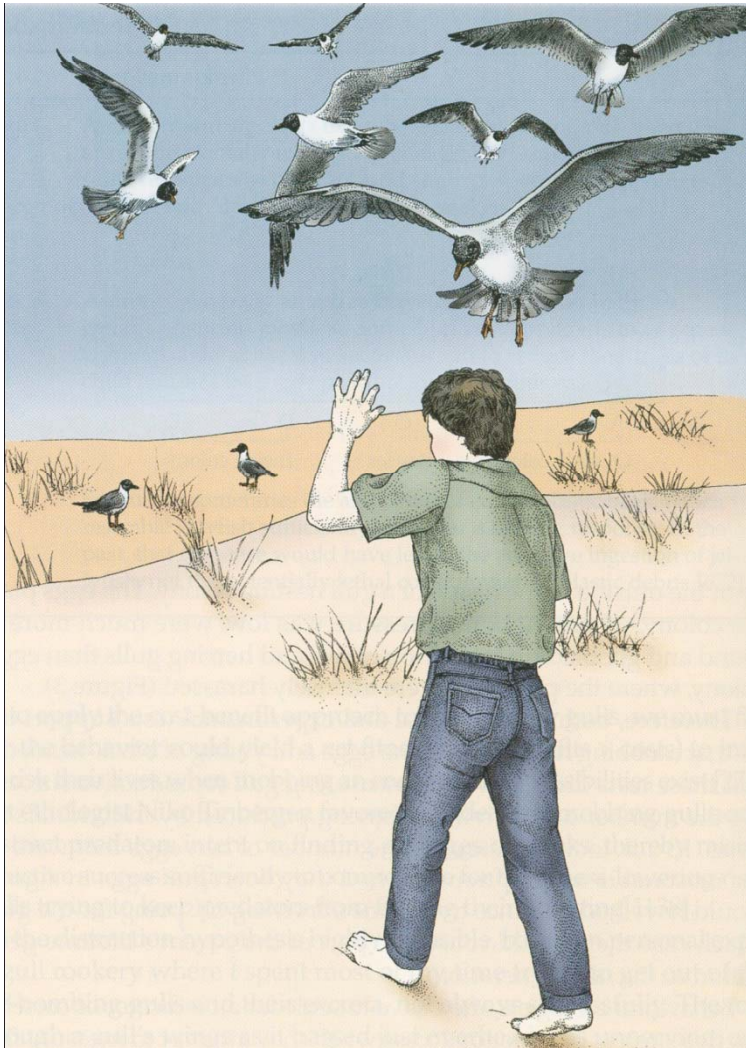


Usually evolved in colonial ground-nesting birds, or mammals.

What if there is no (or less)
selective pressure of
predation?

Will anti-predation behavior
still be evolved?

Mobbing behavior of black-headed seagulls



Hypothesis: in Black-headed Seagulls, mobbing behavior is an anti-predation strategy.

Prediction: If their close relatives have no or less predation pressure, they would not evolve mobbing behavior.

Black-headed gulls are ground-nesting species, eggs and chicks are more vulnerable to land-predators



Close-relative: Kittiwake gulls are cliff-nesting species, have much less predator pressure



No mobbing behavior !

Island species have less or no natural predators

Gradually lost anti-predation behavior

They are **tame** ...



Island species have less or no natural predators

Gradually lost anti-predation behavior

They are **flightless and slow...**



A cormorant species in New York



Flightless cormorant
in Galapago's island

Island species have less or no natural predators

Gradually lost anti-predation behavior

They are **flightless and slow...**



Flying steamer ducks in Argentina



Flightless steamer ducks
in Falkland's island

Island species have less or no natural predators

Gradually lost anti-predation behavior

They are **flightless and slow**...



Flying parrots



Flightless parrots (kakapos)
in a New Zealand island

Island species have less or no natural predators

In the last 500 years, introduced alien species have contributed to the extinction of nearly half of global bird extinctions, mostly by humans and introduced rats, cats, diseases.

Island flightless birds went extinct due to human activities



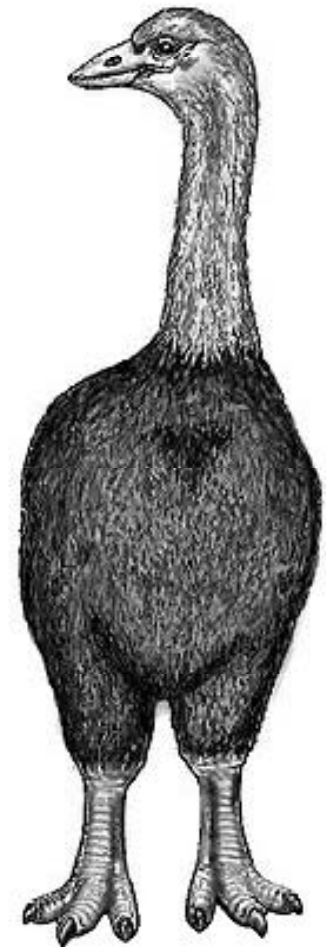
Dodo birds



Stephen island wrens



Hawaii rails



Elephant birds

In islands, **ground nesting** birds have no time to evolve defense strategy against introduced cats, dogs, rats.....

Islands: ground nesting birds



Introduced species may
change the local habitat
and impair local species
diversity.

-- extinction

Invasive Plant Threatens Midway Atoll Seabirds

Over 2,000,000 birds are densely packed into Midway Atoll's 1600 acres. The atoll is home to the endangered short-tailed albatross, the endangered Laysan duck, and the largest populations of Laysan albatross, black noddy, white tern, and red-tailed tropicbird in the world.

Among the 225 non-native plants on Midway Atoll, golden crownbeard is the most invasive, its spread reducing nesting habitat for all ground-nesting birds.

Golden Crownbeard

- ☀ scientific name: *Verbesina encelioides*
Family: Asteraceae
- ☀ an annual flowering shrub
- ☀ native range is debated, but believed to be tropical America and North America
- ☀ in its native habitat, grows from 1 to 5 ft in height at elevations from 0 to 9000 ft
- ☀ is drought-tolerant, requiring only monthly waterings once established
- ☀ its flowers produce up to 350 seeds by both cross- and self-pollination
- ☀ seeds exhibit their highest rate of germination in open, disturbed areas with sandy soils
- ☀ seeds fall from the plant where they reseed existing stands and are also dispersed by wind



Golden crownbeard affects the success of nesting seabirds in several ways:

- Birds do not build nests in existing stands of golden crownbeard; so, existing stands decrease habitat available to nesting birds.
- The growth of new stands of golden crownbeard in areas where birds have already nested enclose and entrap chicks, preventing their parents from locating them for feeding and/or preventing them from finding their way to the ocean when it is time to fledge. These chicks die of starvation.
- Golden crownbeard serves as a home to aphids and scale insects and the ants that tend them. These ants may prey on the eggs and chicks of ground-nesting seabirds and waterfowl. (The scale insects and/or the ants are also suspected in the transmission of a harmful virus from golden crownbeard to native vegetation.)

With the exception of five species, all of Midway Atoll's seabirds nest on or in the ground.

Nine species nest directly on the ground, usually within a shallow, loose bowl of twigs or rocks:

Laysan albatross →
black-footed albatross
short-tailed albatross
red-tailed tropicbird
white-tailed tropicbird
Christmas shearwater
masked booby
gray-backed tern
sooty tern

Two species nest in burrows in the sand:

wedge-tailed shearwater
Bonin petrel



Photo Credit: Christy Finlayson

Introduced plants change the breeding habitat of many seabirds



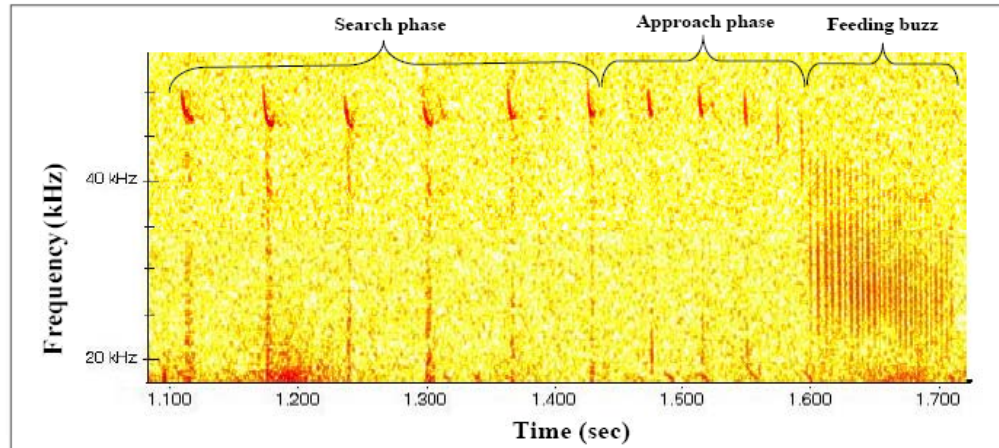
Introduced Golden Crownbeard

Everybody can make a difference

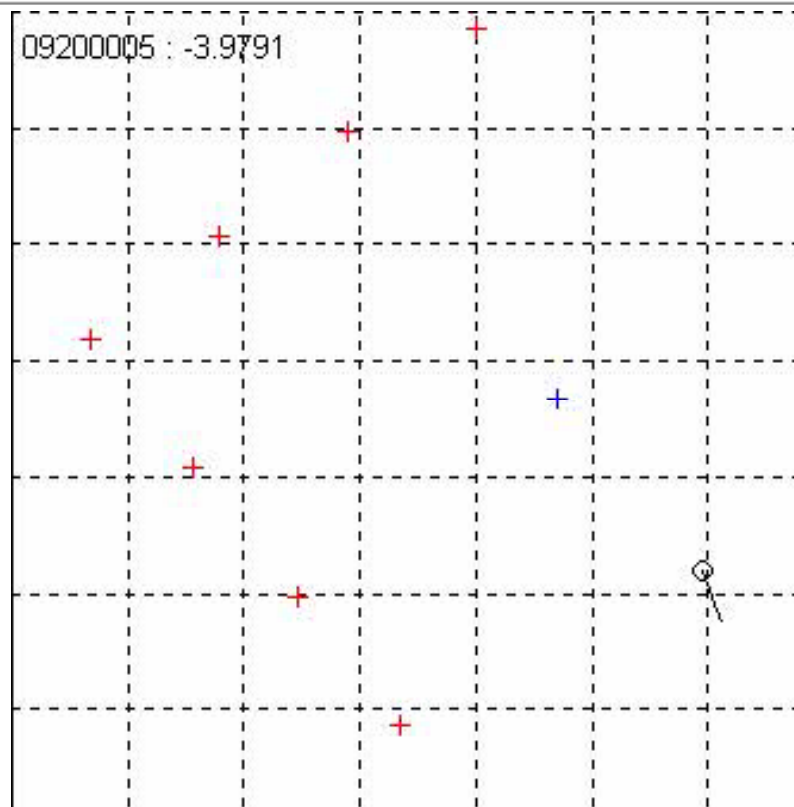


Proximate causes of anti-predator behavior

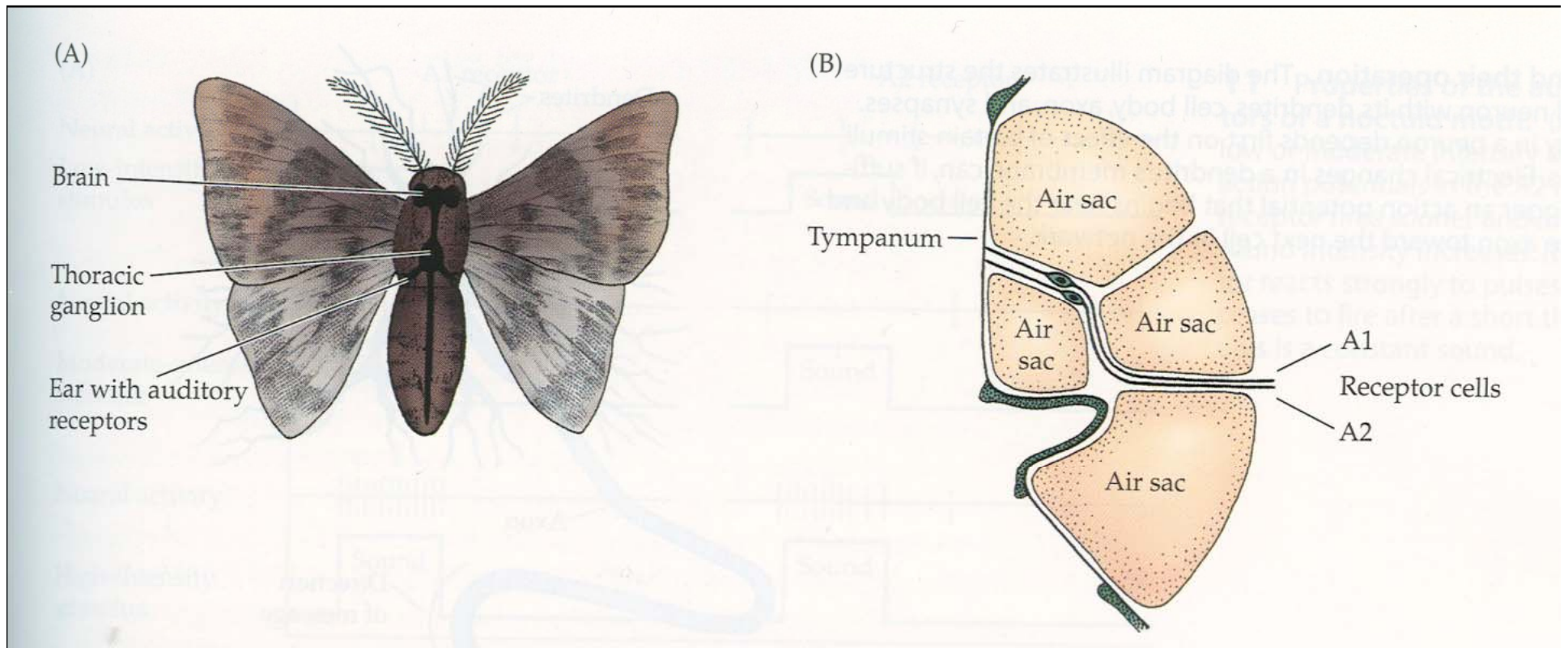
Ultrasound of bats

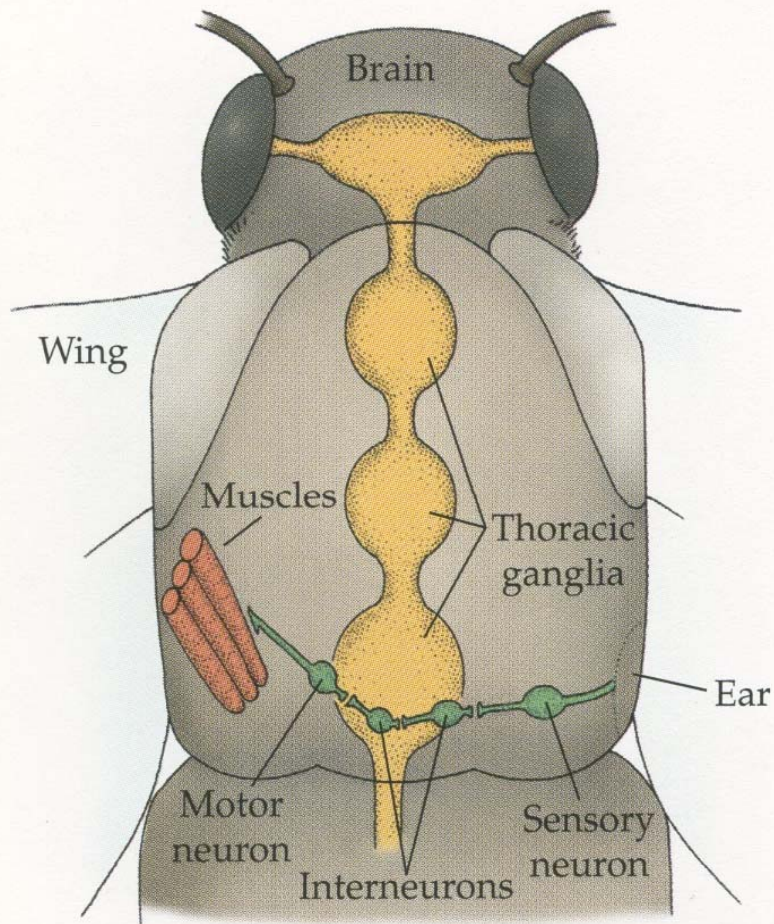


Bat vs. moth



How do moths detect ultrasounds and escape ?





Ultrasound wave

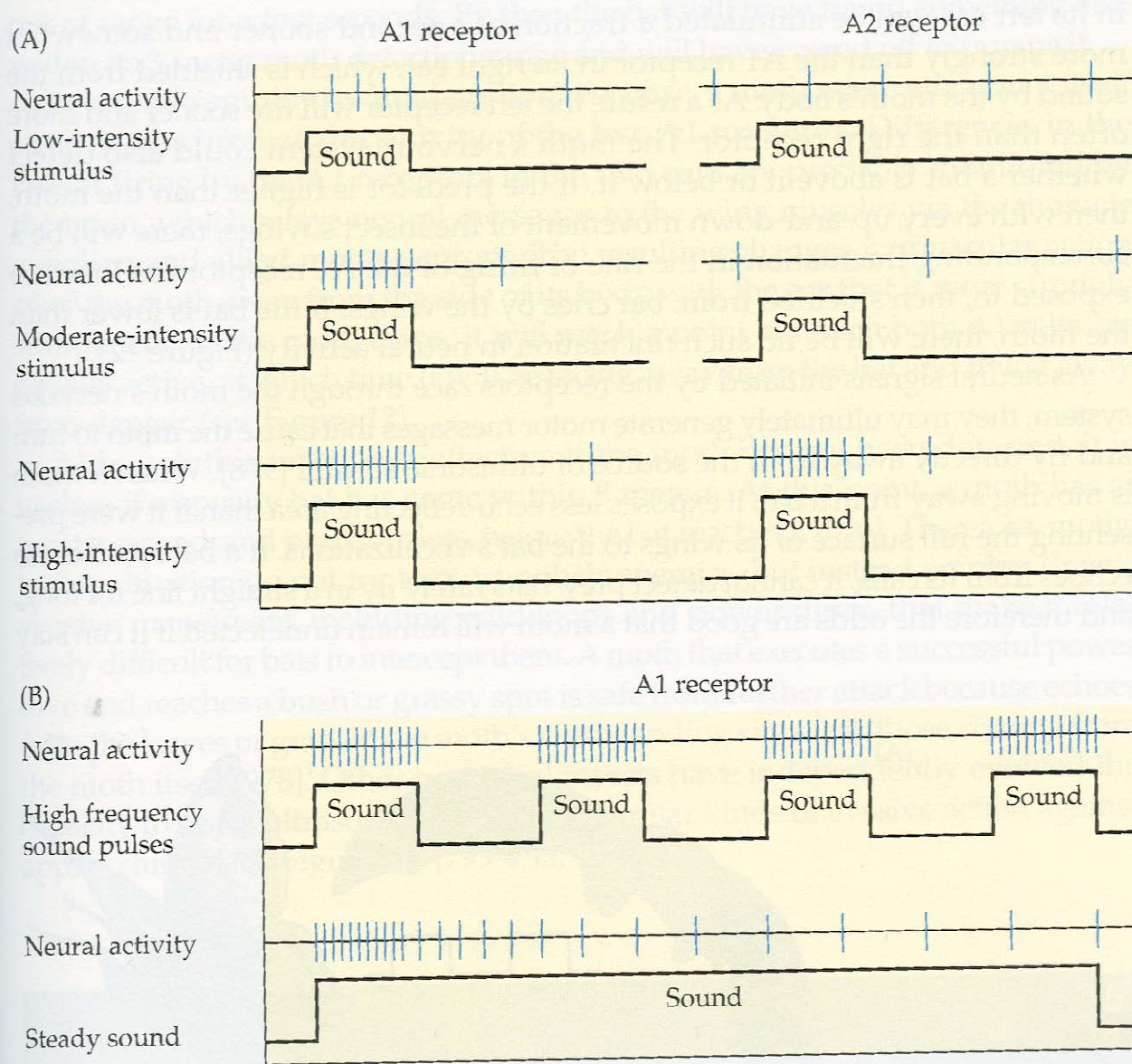
Mechanically change
the tympanum membrane

Vibration induces nerve pulse
--“action potential”

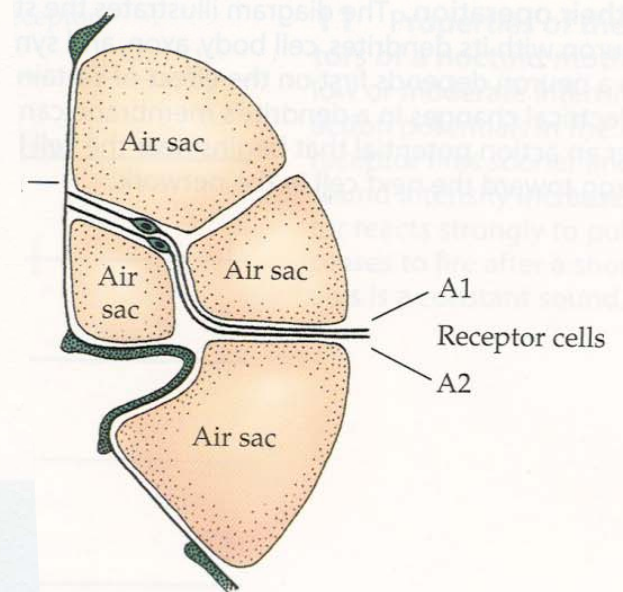
Transmit from sensory neurons
To interneurons through synapse

Interneurons to motor neurons

Muscle movement, escape



A1 and A2 receptors have different responses (initiate action potential) depending on the intensity of sound stimulus



Identify bat's location

When the bat is from left or right

When the bat is from behind

When the bat is from above

